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Pacific Region | Science Response 2014/026

HARVEST ADVICE FOR PACIFIC SARDINE (*SARDINOPS SAGAX*) IN BRITISH COLUMBIA WATERS FOR THE 2014 SEASON

Context

Pacific Sardine (*Sardinops sagax*) from the Northeast Pacific (California Current) population has a distribution that can range between Baja California and Southeast Alaska. In winter and spring months, most of the Pacific Sardine population resides in waters off the California coast. Prior to, and during summer months, large aggregations of Pacific Sardine migrate from key spawning habitat to more northern waters, but the mechanisms behind migratory patterns are unknown but may be affected by population size and oceanographic conditions. Typically, most Pacific Sardine that migrate into British Columbia (BC) waters are the larger and older fish in the population. Pacific Sardine were not observed in 2013 during the annual summer pelagic trawl survey conducted in BC waters, nor were any observed by the Canadian commercial Pacific Sardine fleet. The California Current Pacific Sardine population has been declining since a peak in 2006.

In 2013, Fisheries and Oceans Canada (DFO) adopted a new harvest control rule that applies a harvest rate to the estimate of age-1 and older (age 1+) biomass that exceeds 150,000 t to calculate potential harvest (DFO 2013).

This paper provides information on California Current Pacific Sardine population biomass, exploitation rates, commercial landings, and harvest options for the 2014 BC Pacific Sardine fishing season. Specific objectives of this report are to:

1. Report the results of applying the harvest control rule for a range of harvest rates from 0.03 to 0.05 in increments of 0.01;
2. Identify uncertainties associated with catch advice.

This Science Response results from the December 2013 review of Harvest advice for Pacific Sardine (*Sardinops sagax)* in British Columbia Waters for 2014. A formal assessment has not been undertaken for 2014 and the following advice is based on multi-year methodology approved in 2013. As such, for a full understanding of Science recommendations, uncertainties, and future considerations, readers are referred the 2013 CSAS Science Advice Report (DFO 2013).

Background

Population assessment

The United States (US) Fisheries Service of the National Oceanic and Atmospheric Administration (NOAA) assesses the status and population trend of Pacific Sardine annually using a Stock Synthesis model (Hill et al. 2012, Hill 2013, Methot and Wetzel 2013). Assessments have generated estimates of age-1+ biomass that reflect the stock status in July for use in US and BC fishery harvest control rules (DFO 2012, Hill et al. 2012). Due to a transition in the US stock assessment and fishery management schedules the 2013 assessment model applied 2013 catch data, but 2013 survey and biological data were not included in the

update (Hill 2013). The 2013 assessment provided an estimate of age-1+ biomass for July 2013, and a forecast of age-1+ biomass in January 2014 (Hill 2013). The US Pacific Fishery Management Council adopted the use of an age-1+ biomass forecast for January 2014 into its 2014 fishery harvest control rule, instead of the previous season's July biomass estimate. The intent was to utilize the most current view of the population's status in setting harvest targets at a time when the Pacific Sardine population biomass appears to be declining.

BC Pacific Sardine fishery harvest control rule

In 2013, Fisheries Management adopted the following harvest control rule that incorporates an estimate of the population's age-1+ biomass $B_{1+,t}$, an escapement buffer, or cutoff value, of 150,000 t, and a harvest rate, h. The harvest rate is applied to the difference between the estimated age-1+ biomass and the cutoff:

$$TAC_{2014} = h\,(B_{1+t} - 150{,}000\text{ t})$$

where TAC_{2014} is the potential total allowable catch in 2014. When the estimated age-1+ biomass is less than 150,000 t the recommendation is that there should be no harvest.

This SR provides 2014 BC fishery harvest options based on both the US assessment model's July 2013 age 1+ biomass estimate and the January 2014 age 1+ forecast. As described in the 2013 review (DFO 2013), a range in harvest rates (h) from 3-5% was selected in the calculation of potential harvest allowances.

Analysis and Response

Biomass

The estimates of the Pacific Sardine age-1+ biomass show a decreasing trend from over 1 million tonnes in 2007, to between 300,000 and 500,000 tonnes in 2013. Recent assessments provide no indication of a greater than average year class since 2009 and 2010 (Hill et al 2012; Hill 2013). The age-1+ biomass maximum likelihood estimate for July 2013 is 493,479 tonnes (265,817 – 369,950 t, 90% credible interval) and the January 2014 forecast is 378,120 tonnes (165,400 – 590,840 t, 90% credible interval, Hill 2013).

A pelagic research trawl survey was conducted by DFO off the west coast of Vancouver Island from August 6 to 16, 2013. No Pacific Sardine were observed in any of the 60 tows completed. Estimates of mean Pacific Sardine trawl catch densities (tonnes/km^3) from similar surveys conducted in 2006 and 2008-2012 show a decrease in density since 2006 (DFO 2013).

BC fishery exploitation

The commercial BC sardine fishery was reinitiated in 2002 following a period of closure since 1947 (Ware 1999, DFO 2012). Most fishing has occurred from July to October in association with seasonal migratory behaviour (DFO 2012). From 2002-2012, the annual total allowable catch (TAC), and hence the landings, generally increased as a result of management decisions (DFO 2012). Landings were relatively low prior to 2008 (less than 5,000 t), increased from 2009-2012 because of management/policy changes (10,435 - 22,223 t), and were 0 in 2013 due to an apparent absence of Pacific Sardine in BC waters (Table 1). BC exploitation rates were estimated by the annual fishery landings (C_t) divided by the estimated age-1+ biomass in July. The exploitation rate on the stock due to fishing in BC waters increased from less than 0.5% prior to 2008 to approximately 3% in 2012 (Table 1).

Table 1: Pacific Sardine fishery total allowable catch (TAC) in BC, landings in BC and total landings. Regions represented in total landings are BC, Washington, Oregon, California and Ensenada Mexico. Estimated July age 1+ population biomass ($B_{1+,\ July}$), biomass coefficient of variation (CV), BC exploitation, and Apical F for total landings in population (Hill 2013 pers comm.) are also reported. All TAC, landings, and biomass values are metric tonnes.

Year	BC TAC	BC Landings (*C*)	Total Landings	*Biomass $B_{1+,\ July}$	*CV ($B_{1+,\ July}$)	BC Exploitation ($C/B_{1+,\ July}$)	Apical *F*
2002	5,040	822	148,952	868,532	14.86%	0.09%	0.35
2003	9,000	1,006	116,919	646,971	15.87%	0.16%	0.25
2004	15,000	4,259	138,948	989,222	17.08%	0.43%	0.16
2005	15,200	3,266	148,684	1,118,270	15.20%	0.29%	0.14
2006	13,500	1,558	149,588	1,371,320	14.59%	0.11%	0.14
2007	19,800	1,507	166,065	1,356,870	13.82%	0.11%	0.16
2008	12,491	10,435	164,466	1,279,250	13.99%	0.82%	0.20
2009	18,196	15,334	138,328	1,093,190	14.68%	1.40%	0.17
2010	23,166	22,223	145,935	1,051,900	15.89%	2.11%	0.20
2011	21,917	20,719	137,801	866,584	17.68%	2.39%	0.28
2012	27,279	19,129	170,085	635,551	20.92%	3.01%	0.37
2013	25,477	0	112,296	493,479	28.83%	0.00%	0.18

*2002 biomass estimate from Hill et al. (2012), 2003-2013 biomass estimates from Hill (2013).

Harvest options

The US Pacific Fishery Management Council adopted the use of an age-1+ biomass forecast for January 2014 into its 2014 fishery harvest control rule, instead of a previous season July biomass estimate. This was done to apply a more current view of the population's status with respect to the US fishing season at a time when the sardine population biomass appears to be declining. DFO fishery management may wish to consider those reasons as well as the lag time between a July 2013 biomass estimate and a 2014 summer fishery when setting the BC fishery TAC for the 2014 season.

Based on the harvest control rule adopted in 2013 and harvest rate fractions (*h*) of 0.03, 0.04 and 0.05, harvest options using the July 2013 age 1+ population biomass range from 10,304 to 17,174 t . Harvest options based on the January 2014 forecast range from 6,844 to 11,406 t (Table 2).

Table 2: Total allowable catch options (tonnes) resulting from applying harvest rates of 3%, 4% or 5% to the age 1+ biomass estimate in excess of 150,000 t. Age-1+ biomass estimates obtained from Hill (2013) for July 2013 or a January 2014 forecast.

Population B_{1+}	July 2013 493,479	January 2014 378,120
-Cutoff	-150,000	-150,000
Harvestable biomass	343,479	228,120
Harvest rate	Harvest option	Harvest option
3.0%	10,304	6,844
4.0%	13,739	9,125
5.0%	17,174	11,406

Conclusions

The coastwide sardine stock assessment indicated that biomass appears to be declining. Recent survey and fishery samples, including those collected in 2013, provide no indication of an above average year class since 2009 and 2010. Biomass indices from 2013 acoustic-trawl surveys show no increase from 2012, and these indices will be represented in the next US assessment of the population. The absence of a recent strong year class appears to be responsible for decreases in population biomass (Hill 2013, Hill et al 2012).

Predictions of the stock's trajectory are uncertain. Population size and age composition, coupled with coast-wide fluctuations in climate and ocean conditions, contribute to the variability in the timing and extent of seasonal BC Pacific Sardine migration (Emmett et al 2005, Lo et al 2010). The interaction of these biological and environmental factors is not well understood and consequently, prediction of seasonal occurrence of Pacific Sardine in BC waters is difficult. Ecological data have been collected and some modeling efforts are underway to better understand these dynamics.

Contributors

Name	Affiliation
Linnea Flostrand	DFO, Science Pacific Region
Sean MacConnachie	DFO, Science Pacific Region
Jordan Mah	DFO, FAM, Pacific Region
Kevin Hill	NOAA
Lorne Clayton	Canadian Pacific Sardine Association
Jake Schweigert	DFO, Emeritus
Jennifer Boldt	DFO, Science, Pacific Region
Rob Kronlund (Editor)	DFO, Science, A/CSAP Coordinator
Lesley MacDougall (Editor)	DFO, Science, CSAP Science Advisor

Approved by

Laura Richards, Regional Director of Science
DFO Science, Pacific Region,
Nanaimo, BC
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Centre for Science Advice (CSA)
Pacific Region
Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, British Columbia, Canada V9T 6N7

Telephone: 250 756-7208
E-Mail: mailto:CSAP@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

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